Claims

What is claimed is:

1. A lensed fiber, comprising:
an optical fiber; and
a lens having a neck region and a convex region formed at an end of the optical fiber, the neck region having an overall diameter smaller than an outer diameter of the optical fiber.

2. The lensed fiber of claim **1**, wherein an overall diameter of the lens does not exceed the outer diameter of the optical fiber.

3. The lensed fiber of claim **2**, wherein a radius of curvature of the convex region does not exceed half the outer diameter of the optical fiber.

4. The lensed fiber of claim **3**, wherein the outer diameter of the optical fiber is approximately 125 μm.

5. The lensed fiber of claim **4**, wherein the radius of curvature of the convex region does not exceed approximately 62.5 μm.

6. The lensed fiber of claim **5**, wherein a maximum thickness of the lens is approximately 697 μm.

7. The lensed fiber of claim **4**, wherein the radius of curvature of the convex region does not exceed approximately 53 μm.

8. The lensed fiber of claim **7**, wherein a maximum thickness of the lens is approximately 250 μm.

9. The lensed fiber of claim **2**, wherein a radius of curvature of the convex region is greater than half the outer diameter of the optical fiber.

10. The lensed fiber of claim **1**, wherein the radius of curvature of the convex region is not smaller than a mode field radius at a splice formed between the optical fiber and the neck region.

11. The lensed fiber of claim **2**, wherein the neck region is tapered.

12. The lensed fiber of claim **1**, wherein a back-reflection loss of the lens is -40 dB or lower without anti-reflection coating.

13. The lensed fiber of claim **1**, wherein a back-reflection loss of the less is -55 dB or lower with anti-reflection coating.

14. The lensed fiber of claim **1**, wherein a mode field diameter at beam waist of the lens is approximately 13 ± 1.5 μm.

15. The lensed fiber of claim **1**, wherein a mode field diameter at beam waist of the lens is approximately 16 ± 1.5 μm

16. The lensed fiber of claim **1**, wherein a distance to beam waist of the lens is approximately 260 ± 10 μm.

17. The lensed fiber of claim **1**, wherein a pointing error of the lens is less than 0.5 μm.

18. A method of making a lensed fiber, comprising:

splicing a coreless fiber to an optical fiber, the coreless fiber having a diameter smaller than an outer diameter of the optical fiber; and

controllably applying heat and axial tension to the coreless fiber to form a lens having a neck region and a convex region, the neck region having an overall diameter smaller than the outer diameter of the optical fiber.

19. The method of claim **18**, further comprising enlarging a radius of curvature of the convex region by melting back the convex region.

20. The method of claim **19**, wherein the radius of curvature of the convex region and the thickness of the lens are such that an overall diameter of the lens does not exceed the outer diameter of the optical fiber.

21. The method of claim **20**, wherein the radius of curvature of the convex region does not exceed half the outer diameter of the optical fiber.

22. The method of claim **18**, wherein controllably applying heat and axial tension to the coreless fiber comprises tapering the coreless fiber.

23. The method of claim **22**, wherein tapering the coreless fiber comprises smoothening a region surrounding the splice formed between the coreless fiber and the optical fiber.

24. The method of claim **22**, wherein the diameter of the optical fiber is approximately 125 μm.

25. The method of claim **24**, wherein the diameter of the coreless fiber is approximately 100 μm.

26. The method of claim **18**, wherein controllably applying heat and axial tension to the coreless fiber comprises cutting the coreless fiber to a desired length and applying heat to a distal end of the coreless fiber so that surface tension pulls the distal end into a convex surface.

27. A method of making a lensed fiber, comprising:

splicing a coreless fiber to an optical fiber, the coreless fiber having a diameter smaller than an outer diameter of the optical fiber;

cleaving the coreless fiber to a desired length; and

melting back the cleaved end of the coreless fiber to form a lens having a radius of curvature at its tip and an overall diameter that does not exceed the outer diameter of the optical fiber.

28. The method of claim **27**, wherein the radius of curvature at the tip of the lens is equal to larger than an outer diameter of the optical fiber.

29. A method of making a lensed fiber, comprising:

splicing a coreless fiber to an optical fiber, the coreless fiber having a diameter equal to or larger than an outer diameter of the optical fiber;

controllably applying heat and axial tension to the coreless fiber until the diameter of the coreless fiber becomes smaller than the outer diameter of the optical fiber; and

taper-cutting the coreless fiber to form a lens having a neck region and a convex region, the neck region having a diameter smaller than the outer diameter of the optical fiber.

30. The method of claim **29**, further comprising enlarging a radius of curvature of the convex region by melting back the convex region.

31. The method of claim **30**, wherein the radius of curvature of the convex region and a thickness of the lens are such that an overall diameter of the lens does not exceed the outer diameter of the optical fiber.

32. The method of claim **29**, wherein controllably applying heat and axial tension eliminates any bulge at the splice formed between the coreless fiber and the optical fiber.